TEST DESIGN PLAN, NEW ARMY BATTLE TANK, XM1, OPERATIONAL TEST I (TDP XM1 OT 1)

Army Operational Test and Evaluation Agency
Falls Church, Virginia

January 1976

An Amendment to the test design plan, dated 11 Feb 76, is attached at the end of basic document.

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TEST DESIGN PLAN, NEW ARMY BATTLE TANK, XM1, OPERATIONAL TEST I

TDP XM1 OT I

US ARMY OPERATIONAL TEST AND EVALUATION AGENCY
5600 COLUMBIA PIKE
FALLS CHURCH, VIRGINIA 22041

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

XM1 Operational Test I will be combined with Development Test I at Aberdeen Proving Ground, MD, in a single integrated test, a two-week portion of which will have particular emphasis on operational aspects. Two candidate XM1 tanks, one from each competitor, and an M60A1AOS tank will be used. Six crews will participate in the operational testing: two will be trained on both competitors and the baseline M60A1AOS tank; two will be trained on one of the competitors and the baseline; and two will be trained on the other

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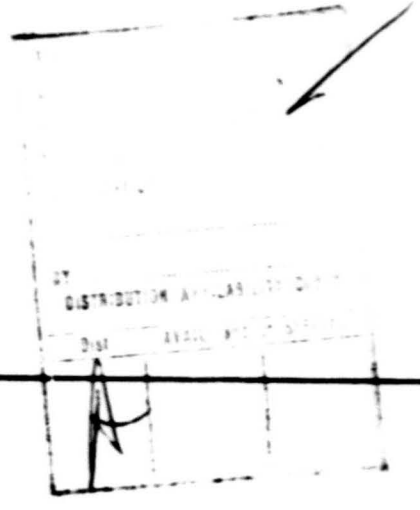
20. competitor and the baseline. Emphasis in operational testing will be placed on test experiences, observations, potential operational problems, and formalized human factors evaluation of activities, conditions, and system components that influence the crews capability to adequately and appropriately operate the tanks. Human factors data requirements for development and operational testing will be integrated and gathered during the entire test period. Objective data will be gathered during the two-week operational test portion of the combined test, but there will not be enough replications of any one activity to permit high statistical confidence levels. The operational activities will be in two basic areas; nonfiring exercises and live fire periods. Crew maintenance activities will be examined and failure data will be reported but none of the standard reliability, availability, and maintainability (RAM) calculations will be made due to the short test period and nontypical maintenance. This test will provide the first opportunity to observe and compare the XM1 with the Mechanized Infantry Combat Vehicle (MICV) in terms of mobility characteristics.



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NEW ARMY BATTLE
TANK, XM1, OPERATIONAL
TEST I

1.0 GENERAL.

1.1 Introduction. The XM1 tank system development program is currently in the validation phase. The Operational Test (OT) I, to be accomplished jointly with the Development Test (DT) I at US Army Aberdeen Proving Ground, will provide information on the relative operational suitability of a General Motors Corporation candidate and a Chrysler Corporation candidate. Both candidates will be compared to the M60A1 tank with add-on stabilization (M60A1AOS) which will be concurrently tested as the reference or baseline system.

1.2 System description. The XM1 will be a fully tracked, low profile, land combat assault weapons system possessing armor-protected firepower and a high degree of maneuverability and tactical agility. Operated by a crew of four, it will mount a large caliber main gun and complementary armament systems to provide a capability to defeat a variety of battlefield targets. To achieve ballistic protection, the XM1 will utilize the most efficient combination of armor materials and design to provide the maximum protection against both kinetic energy and chemical energy penetration.

Technical characteristics are:

weight	49-58 tons
mum speed	40-50 mph
celeration, 0-20 mph	6-9 seconds
Cruising r ige	275-325 miles
Combat mission reliability	320-440 mean-miles-between failure (MMBF)

1.3 Test purposes. To obtain and analyze data as a basis for a US Army Operational Test and Evaluation Agency (OTEA) independent evaluation report to the Army Systems Acquisition Review Council (ASARC II) for its consideration in deciding what full scale development is appropriate.

1.4 Test objectives.

a. Objective 1. Provide information to assess the potential operational effectiveness of the two candidate systems in terms of firepower and mobility with emphasis on the man component of the system.

b. Objective 2. Provide information from which insights as to the operational survivability of the two candidate systems may be gained.

c. Objective 3. Provide information relative to the adequacy of proposed personnel qualifications, training, and selection criteria.

d. Objective 4. Provide information on crew level maintenance and system failures.

1.5 Scope and tactical context.

1.5.1 Scope. XM1 Operational Test I will be combined with Development Test I at Aberdeen Proving Ground, Maryland, in a single integrated test, a two-week portion of which will have particular emphasis on operational aspects. Two candidate XM1 tanks, one from each competitor, and an M60A1AOS tank will be used. Six crews will participate in the operational testing: two will be trained on both competitors and the baseline M60A1AOS tank; two will be trained on one of the competitors and the baseline; and two will be trained on the other competitor and the baseline. Emphasis in operational testing will be placed on test experiences, observations, potential operational problems, and formalized human factors evaluation of activities, conditions, and system components that influence the crews capability to adequately and appropriately operate the tanks. Human factors data requirements for development and operational testing will be integrated and gathered during the entire test period. Objective data will be gathered during the two-week operational test portion of the combined test, but there will not be enough replications of any one activity to permit high statistical confidence levels. The operational activities will be in two basic areas; nonfiring exercises and live fire periods. Crew maintenance activities will be examined and failure data will be reported but none of the standard reliability, availability, and maintainability (RAM) calculations will be made due to the short test period and nontypical maintenance. This test will provide the first opportunity to observe and compare the XM1 with the Mechanized Infantry Combat Vehicle (MICV) in terms of mobility characteristics.

1.5.2 Tactical context. Offense and defense activities will be simulated. In no case will any effort be made to physically portray a tactical unit, nor will the test report make an approach to extrapolating results to unit operations. Operational subtests will be conducted under operational conditions that are as realistic as time and terrain allow.

1.5.3 Ecology. Environmental impact of this test is not considered to be significant.

1.6 Issues addressed. This section, including test criteria, will be completed upon approval of the OTEA Independent Evaluation Plan. It is anticipated that criteria for Operational Test I will be based on the

candidate vehicles showing potential for improvement over the baseline tank. No criteria for RAM performance will be established due to the prototype stage of development at Operational Test I.

1.7 Test milestones.

	Dates
a. Test Design Plan completed	Jul 75
b. Establish OT I Test Directorate at test site.	5 Jan 76
c. Detailed Test Plan completed.	30 Jan 76
d. DT I/OT I begins.	1 Feb 76
e. Operational Test I completed.	1 May 76
f. Interim Test Report.	14 May 76
g. Test Report completed	24 May 76
h. Independent Evaluation completed.	16 Jun 76
i. ASARC II.	24 Jun 76

2.0 TEST CONDITIONS.

2.1 Factors. The factors shown in Table 2-1 have been identified as influencing the performance of the XM1. The general approach in the test is to systematically vary these conditions and examine their effect on system performance.

2.2 Approach to control procedure. Two basic areas will be covered in operational activities, nonfiring field exercises and live fire periods. During the nonfiring field exercises the primary areas to be examined are mobility, agility, and target acquisition. Supplementary areas of interest will be investigated to the extent that time permits. To provide comparison data among the test vehicles, the candidate XM1 tanks from each competitor and a M60A1AOS tank will be evaluated under similar test conditions. Tactical activities will be simulated, but no effort will be made to physically portray a tactical unit. Execution of test events will be controlled by means of a scenario developed for the test and performed in such weather as occurs at the test installation. All test vehicles will operate each trial individually.

2.2.1 Target acquisition. This phase will be conducted in two parts; offense and defense.

a. The offensive courses will be 2 to 3 km in length. Targets for acquisition will be both moving and stationary; they will become available for acquisition either by movement of the test tanks along the course permitting line of sight, or by movement of the targets into line of sight from off-course positions. Targets will be real and as representative of the threat as possible. They will include tanks, APC's, antitank guided missile (ATGM) positions, and E-silhouettes for tank commander's and loader's machinegun targets. The XM1 candidates will run offensive target acquisition under three hatch conditions; all open, all closed, and all closed except the tank commander's hatch popped. The M60A1AOS will run under two hatch conditions; all open and all closed. Eight courses will be needed. Terrain limitations may restrict the geographical areas--in such a case a course may be changed by altering sequence and location of targets along a single avenue. Each course is to be unique; moving targets are to be controlled so as to portray the same sequence for each crew/tank combination. At least one of the moving targets should be a frontal aspect. See Table 2-2 for listing of run requirements. A crew/tank combination will run a particular course only once. If time for conduct of this phase becomes a limiting factor, the open hatch condition has lowest priority. Stationary targets are to be cued to the test vehicles by a controller denoting an artillery simulator or other applicable means when necessary.

TABLE 2-1. FACTORS AND CONDITIONS

Factors	Conditions
General	
Light	Day
System	M60A1AOS, Chrysler XM1, General Motors (GM) XM1.
Crews (No. 485) (No. 366) (No. 152)	2 trained on M60A1AOS and GM XM1. 2 trained on M60A1AOS and Chrysler XM1. 2 trained on M60A1AOS, GM XM1 and Chrysler XM1.
Acquisition	
Target type	Tanks--moving; stationary; exposed; defilade. Armored personnel carriers--moving; stationary. ATGM positions--stationary Troops--stationary.
System mode	Moving, stationary.
Hatches	Closed; popped, open.
Posture	Offense; defense.
Firing	
System mode	Moving, stationary.
Ammunition	HEAT-TP-T; APDS-T; HEP-TP-T.
Live fire range	500m; 1,000m; 1,500m; 2,000m; 2,500m 3,000m.
Targets	Full side silhouette, front silhouette, and frontal turret silhouette of the T-64.
Mobility	
Distance	Short (0.5-0.8km); Medium (2-3km); Long (10-15km)
Agility course	Straight, Zig Zag*

*See paragraph 2.2.3.

TABLE 2-2. OFFENSIVE TARGET ACQUISITION

Crews	Vehicle	Hatch	Course	Targets
1,2,3,6	Chrysler	Closed	1	Moving exposed tank (one)
1,2,4,5	GM	Closed	2	Moving exposed APC (one)
				Stationary antitank guided missile (one)
all	M60A1AOS	Closed	3	Troops (eight)
1,2,3,6	Chrysler	Popped	4	Stationary exposed tank (one)
				Moving exposed APC (one)
1,2,4,5	GM	Popped	5	Stationary antitank guided missile (one)
				Troops (eight)
1,2,3,6	Chrysler	Open	6	Stationary defilade tank (one)
				Stationary exposed APC (one)
1,2,4,5	GM	Open	7	Stationary antitank guided missile (one)
all	M60A1AOS	Open	8	Troops right side (eight)
				Troops left side (eight)

Courses 4 through 8 to be used simultaneously in agility subtest if feasible.

b. The defensive area target acquisition exercises will be conducted from stationary tanks with closed hatches on the M60A1AOS and with the popped mode on the XM1's. Each crew/tank combination will occupy at least two defensive positions. Additional positions may be added if time and resources permit. Targets for each position will be one tank, one APC, and one truck; all will be moving and as representative of the threat as possible. The mobility dash may be incorporated in this part of the target acquisition exercise if a suitable area can be found. The dash would represent movement from a primary to an alternate or supplemental position within the same defensive area.

2.2.2 Mobility. The matrix at Table 2-3 describes the conditions for the required mobility exercises. Exercises 1 and 2 will be accomplished using operational test drivers and tank commanders during mileage accumulated for development test purposes if possible. Exercises 3 and 4 could be conducted at Gunpowder Neck if vehicle transportation becomes a problem. Exercises 3, 4, and 5 are conducted with full crews. The longest run is to represent a situation in which the tanks will simulate a movement to reinforce. To best represent that tactical situation, the tank should leave a simulated assembly area, drive all but the last kilometer on secondary roads with the last kilometer on cross-country terrain, and occupy a defensive position. The mid-length run is to commence with the tank in a defensive position, move on a cross-country route, and end with occupation of a different defensive position. The short run can be combined with the defensive target acquisition exercise described above or can be run separately, representing either the same defensive situation or a final assault from a covered position to an objective. All mobility exercises are to be conducted with tracks in combat configuration. Hostile attempts to track test vehicles are to be made during this phase if feasible (see paragraph 2.2.3, below).

2.2.3 Agility. This part of the DT I/OT I will attempt to examine the capabilities of the candidate vehicles, as compared to the baseline M60A1AOS, to avoid presenting a high hit probability target to a threat tank or antitank guided missile. In this exercise, each crew will drive each tank for which it is qualified from a covered position within range of and in the field of view of a realistic threat tank and ATGM position. Two cross-country courses are to be used: one a straight line requiring acceleration and deceleration, the other a zig-zag. Both courses are to be run at the maximum capacity of the crew/tank. The acceleration/deceleration courses should be relatively straight and require cycles of acceleration followed by deceleration to crawl speed. If possible, the deceleration should be forced by minor obstacles; however, if the terrain available is not conducive to this, then deceleration must be forced by control measures. The zig-zag course should also be terrain oriented, but may also be based on control measures if necessary. Course layout for the zig-zag/weapon fire course is to be made with due consideration to the emerging results of US Army Combat Developments Experimentation Command antitank missile test experiment. In all agility events, the

TABLE 2-3. MOBILITY

Mobility Exercise	Vehicle a/	Aberdeen area	Length	Minimum Replications
1	ATRs, M60	Churchville	10-15km	1 each crew/ veh combination
2	ATRs, M60	Churchville	2-3km	1 each crew/ veh combination
3	PVs, M60	Perryman 3,4	2-3km	1 each crew/ veh combination
4	PVs, M60	Perryman 4	500-800m	1 each crew/ veh combination
5	PVs, M60	Gunpowder Neck	500-800m	1 each crew/ veh combination

a/ ATR--Automotive test rig.
PV--Pilot vehicle.

tanks are to be run at the maximum performance levels the crews can achieve/sustain. The threat will be stationary, instrumented to determine gun lay, and will continuously attempt to track the tested tanks. Threat gunners are to be instructed to track with the cross-hairs on the tanks and not to apply a lead. Estimated length of courses is to be such that the baseline M60A1AOS will require 15-20 seconds to traverse. Course length or duration is to be finally established by the operational test director, based on observation of pilot testing, so as to portray a reasonable cover-to-cover operational situation. Additional attempts to track test vehicles by hostile gunners are to be made during all other phases of this test where the test vehicles present a reasonable portrayal of operational action.

2.2.4 Rate of fire. This is a development test oriented subtest that will be conducted with the cross-trained operational test crews. The subtest is described in the DT I plan and will be run by the development test directorate during its portion of the test.

2.2.5 Operational firing. The matrix at Table 2-4 describes the conditions for the conduct of the operational firings. The matrix is set up for one tank and one crew. Fourteen such matrices will be fired during DT I/OT I in accordance with the activity schedule at Table 2-5. As shown in Table 2-5, only one day's range time is available for each crew/tank combination. This limitation dictates that each crew/tank combination attempt to limit non-matrix firing requirements. The procedure for this will be that each crew will first boresight and then fire a confirming round for each type ammunition to be fired for the XM1 candidates and with APDS only for the M60A1AOS. If the confirming rounds are successful, zeroing will not be done. If the confirming rounds are not successful, zeroing with the type ammunition not confirmed must be done prior to matrix firing. Main gun targets will be silhouettes painted olive drab; these will be representative of a front, side, or turret view of the T64 tank. Because the targets are two dimensional, engagements should be as near as practicable to a perpendicular from the firing tank. Speed of the moving targets is to be varied between 10 and 15 miles per hour. Target dimensions and shapes are shown at Figure 2-1. Conduct of fire must assure that some targets be engaged in paired sequence. It is desirable that three such pairs be established for gunner firing and one pair for tank commander firing. The particular matrix cells selected for paired engagements is dependent on the range capabilities but it is desirable that the two targets in any single sequence be at different ranges. It is anticipated that when a moving target is included in a sequence, it will be most convenient that it be engaged first. Since only one moving target will be available, a sequence requiring two moving targets will not be possible. Suggested pairings are indicated on Table 2-4, but final selection must await detailed planning. All firing is to be done with primary sights unless a failure occurs in these elements of the system; if the failure is not easily repairable,

the secondary sights are to be used to complete firing. Gunsight cameras will not be used for live firing if they interfere with either gunner's or tank commander's sight. If time and resources permit, it is desirable that three to five engagements with HEP-TP-T ammunition be fired by each crew/tank combination following completion of matrix firing. Hostile attempts to track test vehicles are to be made during this phase if feasible (see paragraph 2.2.3).

TABLE 2-4. MAIN GUN LIVE FIRE MATRIX

Tank/tgt	Nominal range meters and ammunition type								
	500	1,000	1,500		2,000		2,500		3,000
mode	H A	A	H	A	H	A	H	A	A
S/S					(tc) 2(d)	2	2(b)	2	2
S/M					2	2	2	2(a)	
M/S	2 2		(tc) 2(d)	2(a)	2	2(c)			
M/M	2 2		2	2(c)	2(b)	2(tc)			
SH/M						2			
S/T		2							
M/T	2	2							

S=Stationary, M=Moving, SH=Short Halt, T=Turret Size Target,
H=HEAT-TP-T, A=APDS-T.
(a through d)--Suggested paired sequential engagements.
(tc)--Engagements to be fired from tank commander's station.
Each cell in the matrix is a two-round target engagement.
Moving tank/moving target engagements are to be distributed over front deck, back deck, right side, and left side. Targets are to move with and against tank motion on side shots.

2.2.6 Schedule. The Test Activity Schedule at Table 2-5 has been compiled to accomplish the following; it minimizes the potential transference problem by scheduling crew/tank activities in blocks of time--there is no switching back and forth; it maximizes use of the firing facilities--this is expected to be the critical time line activity; it maximizes pilot vehicle utilization during the period of time available; and it provides two contingency days in the event that weather or maintenance problems occur. The day-to-day activities must be adhered to

as scheduled in order to avoid loss of crew participation in a cross-section of actions. Crew/tank activities will be run only on the day scheduled or the makeup days. Activities will be skipped if necessary in order to adhere to the schedule. The makeup days may be run if needed, but must be held to the end of a crew/tank time block so the most crucial activity missed may be made up. The decision on which activity is most critical is to be made by the OT deputy test director in conjunction with evaluation division. If on any day the scheduled activity for a crew/tank combination is completed early, the time remaining can be devoted to examination of areas not otherwise covered, or areas in which difficulties have been noted. Data requirements given in Section 3 have priority; others may be added at the discretion of the operational test director upon noting problems.

2.2.7 Other data acquisition. In addition to the major areas of acquisition, mobility, agility, and firing detailed above, there are several smaller scale activities on which data are required and which are to be accomplished whenever the opportunity occurs. These activities are explained below.

a. The maintenance activities identified in the XM1 operator's manual and additional crew maintenance duties as identified in the maintenance allocation chart will serve as the basis for determining the crews' ability to maintain the vehicles and provide insight into maintainability characteristics of the XM1. Daily preventive maintenance (PM) services will be conducted on a before, during, and after operations schedule. Crews will inspect, test, service, or adjust those items specified in the operator manual at the time intervals prescribed. These PM activities will be observed by a trained maintenance data collector and the adequacy of those services recorded. Additional crew maintenance tasks to be accomplished and time are: replacement of a track section (4 blocks); removal and replacement of a complete track; drive sprocket reversal; removal and replacement of sights where this is a crew function; and machinegun barrel replacement, vehicle availability permitting. Maintenance activities, which occur naturally during testing and are performed by the vehicle crew, will be recorded in detail.

b. Use of secondary sights will be primarily from a human factors point of view and for the gunner in particular. All live matrix firings (Table 2-4) will be done with the primary sight unless a failure occurs. Some live firing (three to five two-round engagements for each crew/tank combination) with the secondary sight is desirable if time remains in the activity schedule after matrix firing. These secondary sight engagements may be made with HEP ammunition. Choice of engagement ranges and tank/target modes is to be at the discretion of the deputy director for operational testing.

c Use of manual backup systems (i.e., turret rotation, main gun elevation, and manual firing procedures) for the main gun are to be

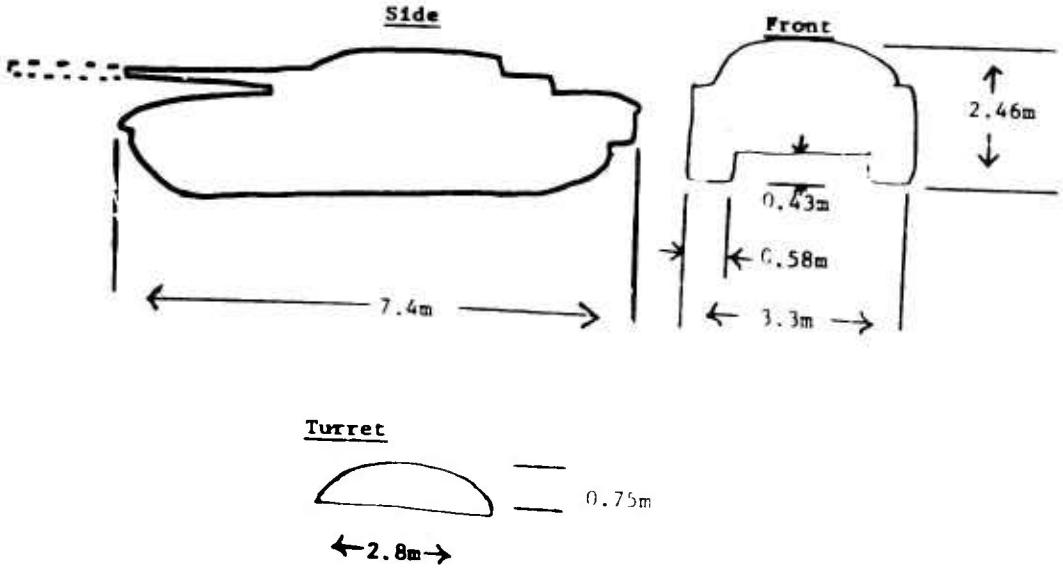


Figure 2-1. Target dimensions

TABLE 2-5. TEST ACTIVITY SCHEDULE

Day	M60A1AOS		GM		Chrysler	
	Crew	Activity	Crew	Activity	Crew	Activity
-7	1	M				
-6	2	M				
-5	1	A				
-4	2	A				
-3	1	F				
-2	2	F				
-1	Make up					
T	[illegible]	A	1	M	3	F
2	6	A	4	F	2	M
3	5	F	1	A	3	M
4	6	F	4	M	2	A
5	5	M	1	F	3	A
6	6	M	4	A	2	F
7	3	A	5	F	1	M
8	4	A	2	M	6	F
9	3	F	5	M	1	A
10	4	F	2	A	6	M
11	3	M	5	A	1	F
12	4	M	2	F	6	A
13	Make up*					
14	Make up					

*Make-up day 13 should be inserted at day 7 if any problems occur in the first complete iteration (days T through 6). The remaining iteration will be slipped by one day in that event.

M--Mobility/Agility.
A--Acquisition.
F--Firing.

accomplished by all crews. Live firings with the manual procedures will only be done if the primary systems fail and cannot be repaired quickly enough to permit completion of scheduled exercises.

d. Boresight procedures will be performed primarily from a human factors point of view. Each crew will accomplish at least one boresight prior to the firing exercises. It is desirable that all crews do this more than once; however, crews 1 and 2 should complete three to five boresightings to assure familiarization and comparability of data. Time to accomplish the procedures is of major importance and will be recorded in detail.

e. Use and operation of loader's and tank commander's machineguns. To include loading and reloading on the move. For the tank commander's machinegun, reloading is to be accomplished from all the various on-board ammunition stowage locations.

f. Immediate action procedures for all weapons. Using simulated stoppages or misfires if no actual incident occurs.

3.0 DATA REQUIREMENTS.

3.1 Types of data. To fulfill the test objectives, OT I will make use of objective and subjective data. Objective data examples are: time to engage, time to complete mission, targets detected, recognized, and engaged, and hit/miss. Subjective data will be collected using crew comments and expert opinions. Human factors data will be gathered through the entire DT/OT. Requirements for both portions will be integrated and the area of human factors will be considered a combined subtest. The description of human factors data in this test design plan is to establish the relation of the body of data from both development and operational portions of the overall test to the requirements established from an operational point of view.

3.2 Data required. The relationship of the subtests described in Section 2 to the dendritic elements is shown in Table 3-1. The dendritic structure at Figure 3-1 shows data requirements as related to the test objectives.

TABLE 3-1.

Subtest	Dendritic Elements
Acquisition	*1.1; *2.1; *3.0; *4.0
Mobility	*1.3; *1.4; *2.0; *3.0; *4.0
Agility	*2.1; *4.0
Live Fire	*1.2; *3.0; *4.0

3.3 Approach to collection procedure. The following paragraphs discuss considerations of data collection methods and are keyed to the dendritic elements.

3.3.1 Time data. Acquisition time-line data (*1.1.2) will be collected by the data collector riding the tank. Tape recording of the tank intercom will provide a backup. Interval times will be of greatest importance in analyses. The time line from target available for detection (or cue) to final aim may be further subdivided if appropriate. Detection time is the time of first indication by any crew member that a target has been spotted. Identification is when the gunner has found the target in his sight, aim is the time when the gunner has laid on the target and announces that he has fired. Gunsight cameras are to be used to confirm that identification and aiming by the gunner have in fact occurred

*An asterisk is prefixed to each item in the dendritic to make a distinction between dendritic numbers and paragraph numbers.

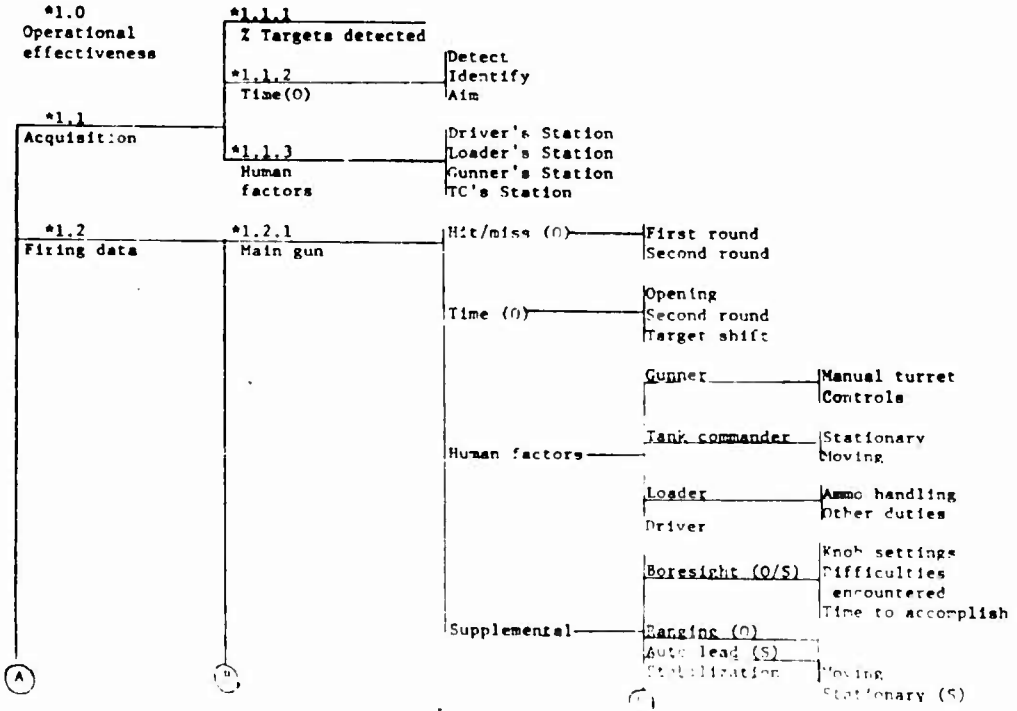
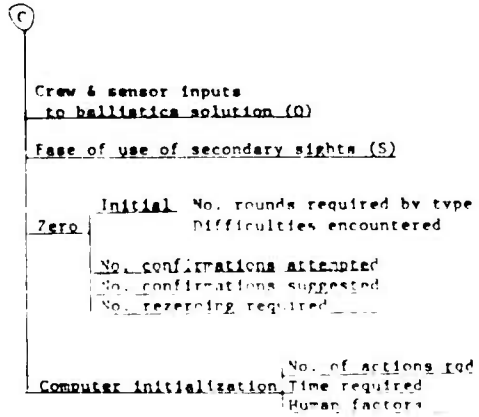
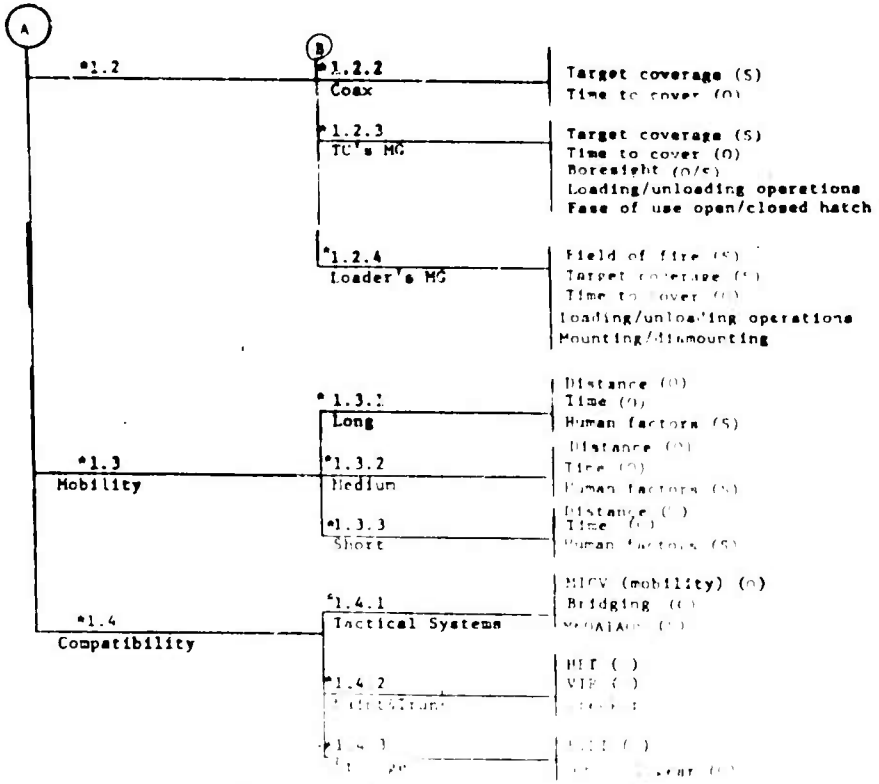


Figure 3-1. Dendritic structure.



*An asterisk is prefixed to each item in the dendritic to make a distinction between dendritic numbers and paragraph numbers.
Notes: O = objective data.
S = subjective data.

Figure 3-1. Dendritic structure (continued).


A
B
*1.2
*1.2.2
Coax
Target coverage (S)
Time to cover (O)
*1.2.3
TC's MG
Target coverage (S)
Time to cover (O)
Boresight (O/S)
Loading/unloading operations
Ease of use open/closed hatch
*1.2.4
Loader's MG
Field of fire (S)
Target coverage (S)
Time to cover (O)
Loading/unloading operations
Mounting/dismounting
*1.3
Mobility
*1.3.1
Long
Distance (O)
Time (O)
Human factors (S)
*1.3.2
Medium
Distance (O)
Time (O)
Human factors (S)
*1.3.3
Short
Distance (O)
Time (O)
Human factors (S)
*1.4
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*1.4.1
Tactical Systems
MICV (mobility) (O)
Bridging (O)
*1.4.2
HEF ( )
VIP ( )
*1.4.3

Figure 3-1 [illegible]

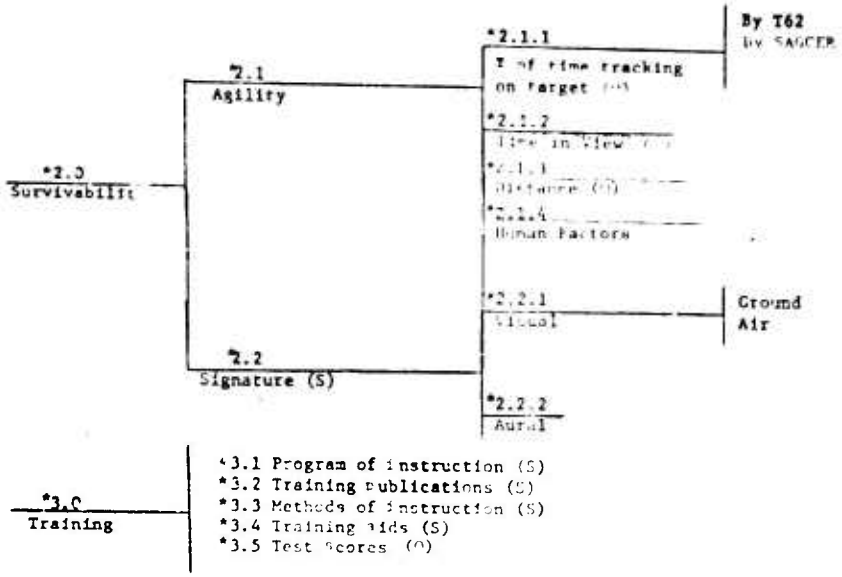

Figure 3-1. Dendritic structure (continued).

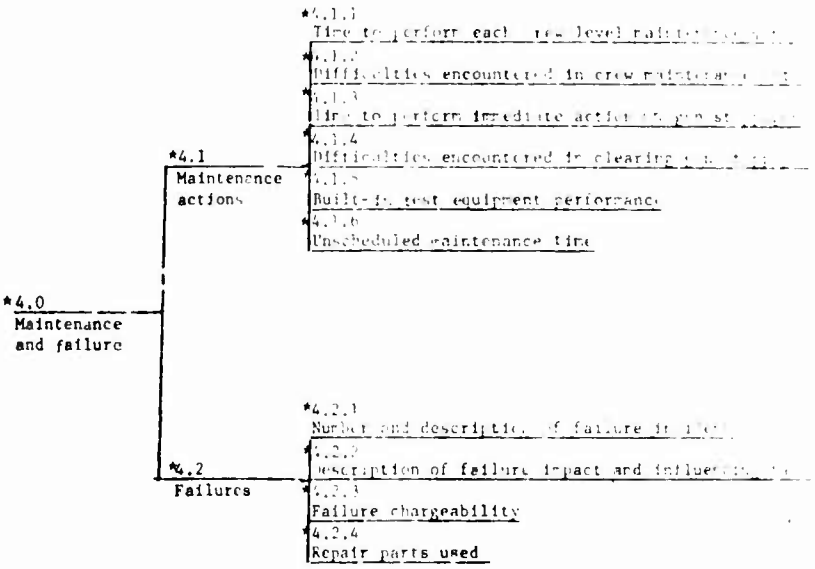

Figure 3-1. Dendritic structure (continued).

for main or coaxial gun targets. Prime interest in time of acquisition is for the main gun. Data collection judgment will be necessary for determining time when aim has occurred for commander's and loader's machineguns. As a general rule, this will be when the data collector decides the machinegun is pointed in the direction of the target.

3.3.2 Human factors. Human factors data for acquisition, dendritic element *1.1.3, is only for those considerations related to acquisition. This information is to be gathered by means of a structured interview and is to be referenced to the hatch conditions for which it applies.

3.3.3 Main gun firing data. (Dendritic element *1.2.1.)

a. Hit sensings from the range television system are to be confirmed by photos or other means. Impact points are to be recorded

b. Times are to be collected by the collector on the tank. Opening time begins with the first word of the fire command and ends with the firing of the first round. Second round time is the time from firing of the first round to firing of the second round. Target shift time is the time from firing the final round at the first target to firing the initial round at the second target.

c. Human factors data related to crew performance are to be gathered by means of structured interview with each crew member. Instrumentation will be utilized to the extent possible to obtain objective data on environmental and safety conditions related to crew positions. This may be limited by the requirement that it not interfere with crew operations. Of specific interest is an examination of any actual or potential confusion on the part of the loader in determining the location in the rack of the type round called for in the fire command. Accessibility of all on-board main gun ammunition should also be addressed.

d. Supplemental data will require the following.

(1) Impact points for all zero and confirming rounds.

(2) Range used for each engagement. Number of re-rangings due to multiple returns, and if practicable, the time required to re-range.

(3) Gunner debriefing on auto lead.

(4) Gunner debriefing on stabilization effects for both moving and stationary engagements.

(5) Gunsight cameras are to be used on all main gun engagements where possible. It will probably not be possible to use the gunsight camera on certain engagements, depending on the requirements for its installation. (For instance, on the tank commander engagements if the gunsight camera installs in place of his evepiece.)

(6) On-board or telemetry recording is highly desired to determine inputs to the ballistic computer for main gun firings. This should include both automatic sensor inputs and manual control inputs (.g., ammunition selection). Detailed requirements and capabilities must be determined through continuing discussions with the Project Manager, test integration working group, and contractor personnel.

(7) Boresight operations and computer initialization will be conducted and reported with a particular emphasis on complexity of required actions.

3.3.4 Machinegun firing data. Subjective opinions will be obtained by both the collector and gunner on target coverage with the machinegun. Time to cover the targets will be gathered by the data collector. Particular attention should be paid to field of fire provided the loader's machinegun, ease of moving it from one pintle position to another, and any interference with the tank commander's machinegun or its field of fire.

3.3.5 Mobility data. The obtaining of mobility data will require stopwatch time on short, medium, and long distance segments. Crew opinions are to be gathered and related to terrain type for each crew position regarding comfort and safety.

3.3.6 System compatibility. Three areas will be checked for system compatibility: tactical systems, maintenance and transportation equipment, and on-vehicle stowage. In all cases the main data requirement will be to look for and record any difficulties.

a. If the MICV is available, it will run the mobility courses and time to complete them must be gathered as for the tanks.

b. Bridging compatibility will be based on observations of the tanks crossing the armored vehicle launched bridge (AVLB). This may be integrated into either the mobility or acquisition phases of the test.

c. M60A1AOS compatibility with XM1 candidates will be based on observations and data gathered throughout the test. No unique data requirements or collection effort is required for this dendritic element.

d. The VTR is to be used to remove power packs, winch, and tow the candidates. Data required will be observations of any difficulties

encountered. Development test actions should be observed, and if accomplished, then a special subtest will not be necessary during operational testing.

e. The XM1 candidates are to be loaded on heavy equipment transporters and moved. Data required will be observations of any difficulties encountered. It is desirable that this be accomplished during development test or as a necessary adjunct to other testing. A special subtest should be conducted only if all other testing is complete and time remains on the make-up days. The priority for this subtest is lower than for d. above.

f. The wreckers are to be used in maintenance actions. Of particular interest will be any power pack removals. Data required will be observations of any difficulties encountered. Development test actions should be observed, and if accomplished, then a special subtest will not be necessary during operational testing. The primary for this subtest is lower than e. above.

g. All BILI and personnel gear normally expected to be carried is to be loaded. Data required will be observations of any equipment not accommodated or that present awkard or interfering conditions.

3.3.7 Agility data. Data collection for dendritic element *2.1 will require gun or gunsight cameras and stopwatches. Tracking capability of threat vehicles and weapons will be determined by analyses of their filmed efforts to track the XM1 candidates and the baseline M60A1AOS. Time in view will be obtained by a data collector at the threat position.

3.3.8 Signature data. For dendritic element *2.2, signature data will be obtained by recording the judgments of observers. Particular attention is to be given to size, shape, and peculiar cues such as exhaust smoke or unusual noise characteristics.

3.3.9 Training data. Data collection for dendritic elements *3.1 through *3.4 will be based on interviews with individuals experienced in providing training to tank crews and interviews with crew members regarding their opinions of adequacy of the program. The primary aim of this part of the data collection program is to obtain information useful in modifying and improving the training package prior to the next stage of system acquisition.

3.3.10 Test scores. Data collection of test scores, dendritic element *3.5, will serve as part of the basis for determining readiness of the crew to enter Operational Test I. Both knowledge and proficiency are to be checked for each crew member. Actual form of the tests to be administered is to be determined through coordination with the US Army Armor School. Final determination of crew readiness to start the test will be made at an in-process review to be held the end of pre-test training.

3.3.11 Failure data. For dendritic element *4.2, all equipment incidents (failures and/or malfunctions) which occur during the test period will be recorded. Time and test resource constraints are such that no numerical estimates will be made in the areas of reliability, availability, or maintainability. Incidents which are recorded will be categorically classified so as to correctly assess the chargeability of the incident to equipment failure, crew error, accidental damage or other appropriate categories. Unscheduled maintenance services will be provided by APG shops when necessary. The capabilities and personnel of these facilities do not represent the normal type of maintenance facility which would be exercised in an operational test. Actual maintenance times and equipment downtime will be recorded, but as a result of the artificial nature of the maintenance facility, these data will not enter into any RAM calculations. Repair parts used during the test will be recorded and reported. No form of logistic support concept will be evaluated.

3.3.12 Maintenance data. For dendritic element *4.1, crew maintenance data will be collected during performance of daily, scheduled, and unscheduled maintenance. Operator maintenance will be performed in accordance with appropriate maintenance manuals. Time to perform each scheduled and unscheduled maintenance task will be recorded along with the date-time group, operating hours, tachometer hours, rounds fired, and vehicle miles at the time of the incident. Operation and utility of built-in test equipment will be examined. Failed components will be identified and reported. Each malfunction will be identified with sufficient information to determine its chargeability as a failure.

4.0 ANALYSES.

4.1 General. A strong emphasis in analyses will be to compare the XM1 candidates with the baseline M60A1AOS series tank in an effort to address the capability of the crews to operate the tank. This will require an intensive look at the results of human factors data and the support provided these judgments by the objective data gathered. For example, the loaders may complain about the working conditions at the loader's station in one of the candidates. These opinions should be balanced against objective data on rate of fire and times to second rounds. Gunners may prefer one candidate's fire control but actually perform better with the other. Analyses of gunner/tank performance will be enhanced through use of the ballistic computer input recordings. Both opinions and performance must be examined with a view toward training received to address whether additional, or different, training might be suggested. Environmental data, obtained by instrumentation will be analyzed to determine comparative relationships between the candidates and the baseline M60A1AOS series tank. The data, in conjunction with that obtained during development testing, will also be analyzed on an absolute level for safety.

4.2 Firing results. Each crew/tank combination will fire according to the matrix in Table 2-4. This matrix, repeated for each possible crew/tank combination, yields for analysis the two full factorial matrices shown in Tables 4-1 and 4-2. The technique of multidimensional contingency table analysis will be applied to each matrix individually and for the factor combination which they have in common, the two columns under the 2,000 meter range, they will be analyzed together to test for differences between moving and stationary firing modes. Those factors and factor combinations which appear to have the most significant effect on performance will be identified and their relative influence on hit probability for this test will be reported.

4.3 Time measures. Time data will be collected during the acquisition, firing, and the mobility subtest. Some key time measures will be time from detection to acquisition, time from acquisition to firing, time from first round to second round, and time to perform specific movement exercises; other time measure may be included as appropriate. These measures will be analyzed using paired comparison hypotheses tests where the candidate tanks are compared with the baseline and with each other.

4.4 Reliability, availability, and maintainability (RAM). Failure and maintenance data will be collected and reported. Analyses of this data will be limited due to both the limited test period and the prototype stage of development. No RAM requirements are identified to be met at Operational Test I. The ability of the crews to perform crew level

maintenance will be examined and any higher level maintenance performed by the contractor will be observed. Any difficulties encountered or potential problem areas will be reported.

4.5 Gunsight camera. Gunsight camera film analyses is to concentrate on sight picture and smoothness of tracking. In the target acquisition nonfiring phase, the film is to be used to confirm gunner lay at time of simulated firing to ensure that the time from initial acquisition to final lay is valid.

TABLE 4-1. MATRIX FOR ANALYSES OF MAIN GUN FIRINGS FROM MOVING TANK

Tank/ crew No.	Target mode	Nominal range (meters) and ammunition type					
		500		1,500		2,000	
		H	A	H	A	H	A
M60/ 1,2	S						
	M						
M60/ 4,5	S						
	M						
M60/ 3,6	S						
	M						
GM/ 1,2	S						
	M						
GM/ 4,5	S						
	M						
CHR/ 1,2	S						
	M						
CHR/ 3,6	S						
	M						

H=HEAT-TP-T; A=APDS-T.
Crews 1&2 trained on M60A1AOS, Chrysler, GM.
Crews 4&5 trained on M60A1AOS, GM.
Crews 3&6 trained on M60A1AOS, Chrysler.

TABLE 4-2. MATRIX FOR ANALYSES OF MAIN GUN FIRINGS FROM STATIONARY TANK

Tank/ crew No.	Target mode	Nominal range (meters) and ammunition type			
		2,000		2,500	
		H	A	H	A
M60/ 1,2	S				
	M				
M60/ 4,5	S				
	M				
M60/ 3,6	S				
	M				
GM/ 1,2	S				
	M				
GM/ 4,5	S				
	M				
CHR/ 1,2	S				
	M				
CHR/ 3,6	S				
	M				

H=HEAT-TP-T; A=APDS-T.
Crews 1&2 trained on M60A1AOS, Chrysler, GM.
Crews 4&5 trained on M60A1AOS, GM.
Crews 3&6 trained on M60A1AOS, Chrysler.

5.0 RESOURCES REQUIRED. To implement this test design the resources listed in Tables 5-1 through 5-4 will be required.

TABLE 5-1. VEHICLES

Quantity	Item
1	M60A1AOS baseline tank.
1	XM1 prototype from each candidate.
1	XM1 automotive test rig from each candidate.
1	Threat tank, (T62 or M60).
1	Threat APC, (BMP or M113).
1	Threat ATGM, (SAGGER, SS-11, or ground mounted tow).
1	Scout helicopter.
1	5-ton wrecker.
1	M88 VTR.
1	GOER 8-ton wrecker.
1	Tank transporter.
1	AVLB.
1	MICV

TABLE 5-2. TARGETS

Item
Front silhouettes of T64.
Side silhouettes of T64.
Turret sillhouettes of T64.
"E" silhouettes for machinegun engagements.

TABLE 5-3. INSTRUMENTATION

Item
Gunsight cameras for XM1 candidates and M60A1AOS.
Gunsight cameras (preferred) or gun cameras (secondary for threat tank and antitank guided missile.
Hour meters and counters.
Stopwatches.
Tape recorders for tank intercoms.
Handheld or range cameras for recording hit locations.
Tape recorders (to be used for interviews and for interviews and for observational comments).
Means to automatically record crew and sensor inputs to fire-control computer for main gun firings.

TABLE 5-4. AMMUNITION

Rounds	Item
200	105mm HEP-TP-T.
400	105mm HEAT-TP-T.
600	100mm APDS-T.
5000	Cal .50, linked.
1500	7.62mm, linked.

ABBREVIATIONS AND ACRONYMS

APC	armored personnel carrier
APDS	armor piercing discarding sabot (ammunition)
APDS-T	armor piercing discarding sabot with tracer (ammunition)
ASARC	Army Systems Acquisition Review Council
ATGM	antitank guided missile
ATR	automotive test rig
AVLB	armored vehicle launched bridge
BILI	basic issue list items
CDEC	US Army Combat Developments Experimentation Command
CHRY	Chrysler
DT	development test
GM	General Motors
HEAT	high explosive antitank (ammunition)
HEAT-TP-T	high explosive antitank, target practice with tracer (ammunition
HEP	high explosive plastic (ammunition)
HEP-TP-T	high explosive plastic, target practice with tracer (ammunition)
HET	heavy equipment transporter
MICV	Mechanized Infantry Combat Vehicle
MMBF	mean-miles-between-failure
mph	miles per hour
No.	number
OT	operational test
OTEA	US Army Operational Test and Evaluation Agency
PM	preventive maintenance
PV	pilot vehicle
RAM	reliability, availability, and maintainability
SAGGER	antitank missile
TIWG	test integration working group
VTR	vehicle, tank retriever

DEPARTMENT OF THE ARMY
UNITED STATES ARMY OPERATIONAL TEST AND EVALUATION AGENCY
5600 COLUMBIA PIKE
FALLS CHURCH, VIRGINIA 22041

DACS-TED-M

11 FEB 1976

SUBJECT: Amendment to Test Design Plan, XM1 OT I

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1. Reference: Test Design Plan, XM1 OT I, 8 January 1976.

2. This amendment provides additional detail on test conditions for the target acquisition phase at paragraph 3, below, adds a requirement for limited night driving exercises at paragraph 4, expands the section on survivability to include elements of ammunition compartment integrity, and provides added sections to the dendritic covering data requirements for these areas (Incl 1).

3. The target acquisition phase described in paragraph 2.2.1 of reference is described here in additional detail. Short of actually firing, the acquisition exercises will cover all aspects of vehicle fightability and interactions between crew members. The phase might better be described as a "fightability phase", of which target acquisition is a major part. Tactical communications should be simulated during the acquisition phase with the controller taking the part of the platoon leader or company commander. This will require the commander of the tested tank to perform duties and interact in a manner that would be expected in a unit operation. All crew members are to perform their normally required duties during the simulated engagements; dummy rounds are to be provided for the loader. In the closed and open hatch modes (see Table 2-2 of reference), one of the targets should be available for acquisition at a range beyond 2,000 meters, with a range of 2,500 to 3,000 meters preferred, if practical at the test site. Additionally, each crew/tank combination should be presented with situations portraying multiple targets. These should be set up so that at a particular location along the course three or more targets become available for acquisition in sequence while the previous target is still being engaged. These exercises will permit loading under more severe conditions of movement and terrain than can be expected during actual live fire (because of safety constraints). These conditions will add to the human factors data concerning the loader's station and may provide useful additional objective data on times to reload (see dendritic 1.1.4 at Inclosure).

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The objective data on times to load will be constrained because of the lack of automatic round extraction. For these dry-fire exercises the breech is to be open prior to start of the engagement; times to be gathered are to represent time to load the second round of the engagement. The time line for loading is to start with the Tank Commander's announcement of type of ammunition to be used for the engagement and is to end with the loader's announcement that the round has been loaded. These times should be carefully compared with times to load during live firing to ensure that the necessary conditions during dry fire have not affected the validity of the times.

4. Night driving exercises are to be conducted with each crew/tank combination. The AN/VVS-2 Night Vision Driver's Viewer will eventually be incorporated in the XM1; it is not available for OT I however, and these exercises will therefore be of a degraded mode operation. The driver will have no visual augmentation device; the tank commander will have the AN/VVS-5 "Cav-Nav" goggles that are standard in the TOE. Two types of exercises will be run; the first will entail a convoy simulation with the tanks following a lead vehicle which has the "cat-eye" tail lights on. This will be run on improved or secondary roads and will be about five miles in length. The second exercise will be cross-country, will be 1,500 to 2,000 meters in length, and will not be following another vehicle. Safety is a paramount consideration in the night driving. Controllers should be equipped with adequate night vision devices so the exercises can be monitored. Ambient light levels should be as similar as possible for comparison runs, suggesting that all the runs be conducted in a single night or that all convoy runs be done in one night and all cross-country runs be done during a second night.

5. Under survivability, one additional area of interest is added covering the problems encountered in maintaining the integrity of ammunition compartmentalization while operating the XM1 prototypes, especially while firing the main gun. The number of times the compartment is open, the duration of each occurrence, and any observed problems will be noted and recorded.

6. This amendment together with the basic test design will be used as the Test Design Plan for the Leopard AV testing scheduled for this fall. The test activity schedule will be modified to reflect the two tanks (Leopard AV and M60A1AOS) that will be used rather than the three tanks, but all test activities for the Leopard AV will be the same as for the Chrysler and General Motors XM1 prototypes.

FOR THE COMMANDER.

1 Incl
as

RICHARD B. MAJOR
LTC, GS
Executive Officer

DACS-TED-M
SUBJECT: Amendment to Test Design Plan, XM1 OT I

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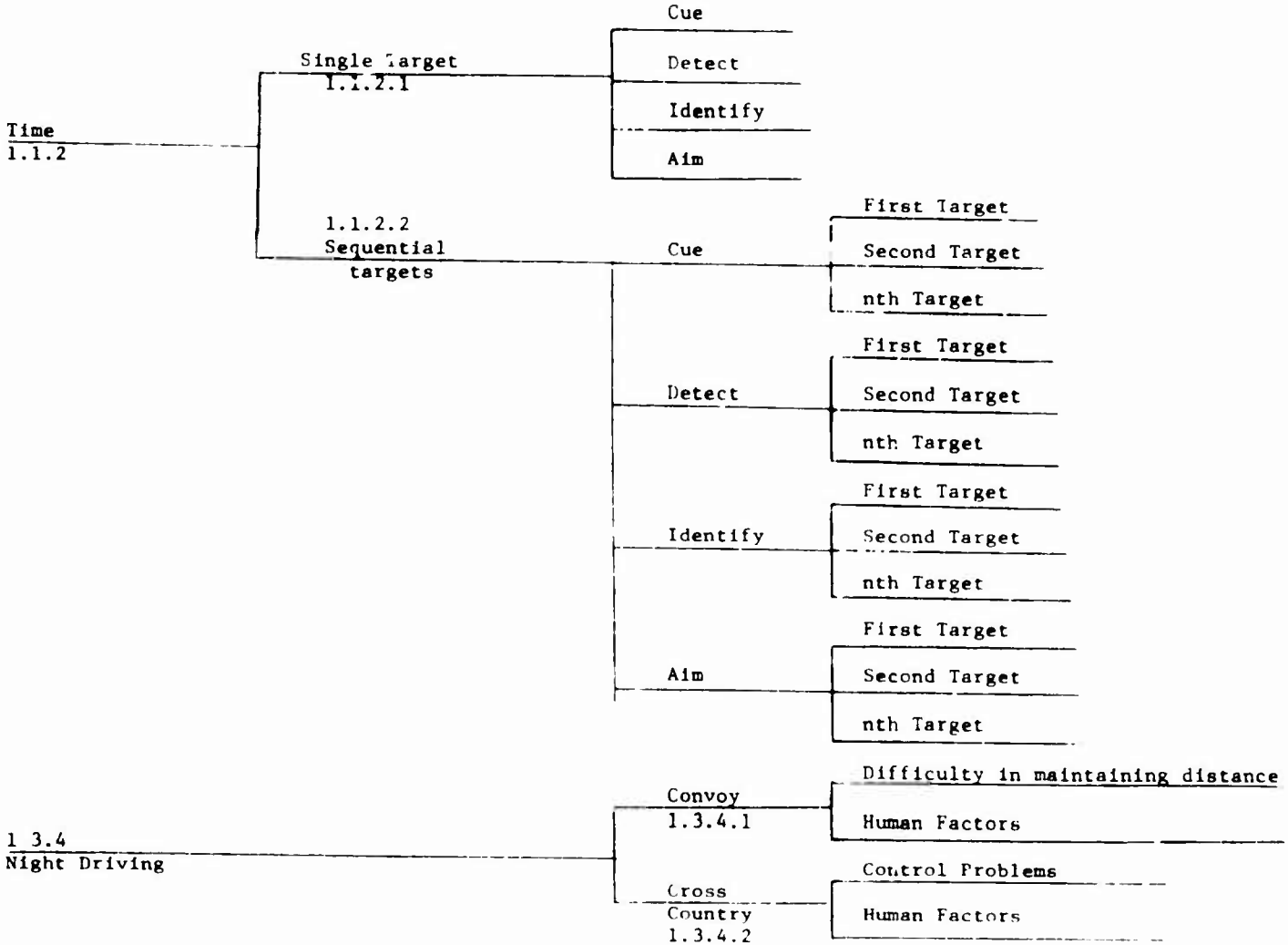
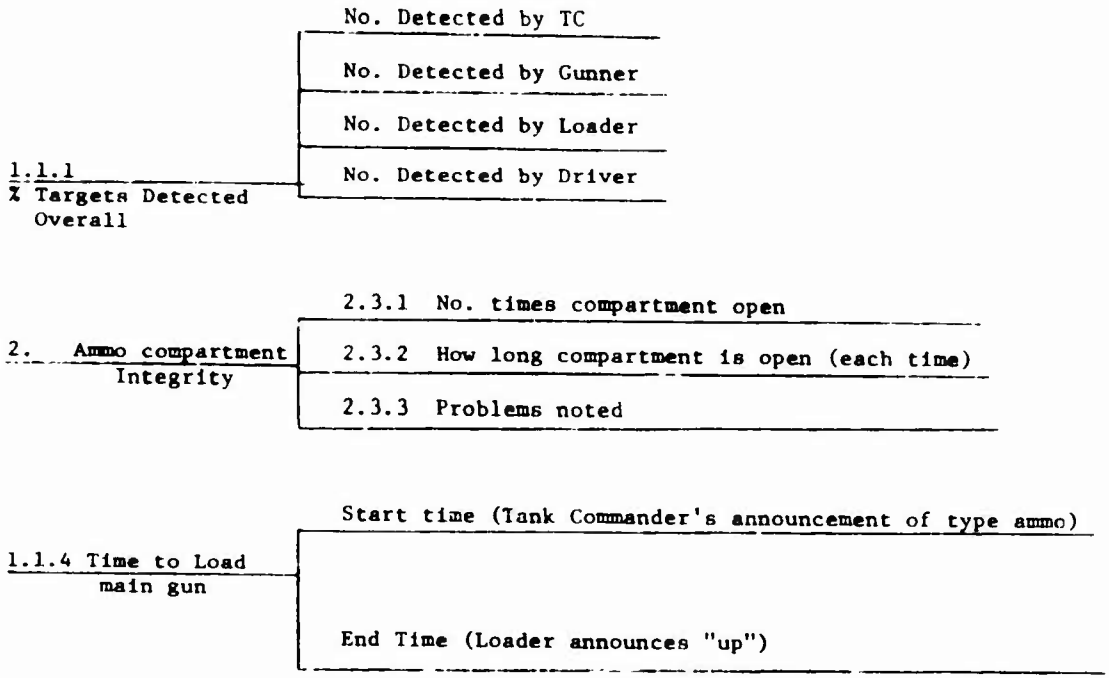

Time
1.1.2
Single Target
1.1.2.1
Cue
Detect
Identify
Aim
1.1.2.2
Sequential
targets
Cue
First Target
Second Target
nth Target
Detect
First Target
Second Target
nth Target
Identify
First Target
Second Target
nth Target
Aim
First Target
Second Target
nth Target
1.3.4
Night Driving
Convoy
1.3.4.1
Difficulty in maintaining distance
Human Factors
Cross
Country
1.3.4.2
Control Problems
Human Factors


No. Detected by TC
No. Detected by Gunner
No. Detected by Loader
No. Detected by Driver
1.1.1
% Targets Detected
Overall
2.3.1 No. times compartment open
2. Ammo compartment
Integrity
2.3.2 How long compartment is open (each time)
2.3.3 Problems noted
Start time (Tank Commander's announcement of type ammo)
1.1.4 Time to Load
main gun
End Time (Loader announces "up")